FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Game engine for development of pervasive games for learning programming

Marina Filipa Franco Camilo

Mestrado Integrado em Engenharia Informática e Computação

Supervisor: António Fernando Coelho

Co-Supervisor: Pedro Jorge Couto Cardoso

July, 2018

Game engine for development of pervasive games for learning programming

Marina Filipa Franco Camilo

Mestrado Integrado em Engenharia Informática e Computação

July, 2018

Abstract

Nowadays, we face a technology growth period that promotes the learning of programming in more professional backgrounds. However, the process of teaching this area is complex and abstract. Over time, several methodologies have been developed to improve students' motivation.

This dissertation is going to take advantage of the fact that mobile devices had become part of our everyday use and it will be focused on the development of a game engine in Unity to implement pervasive games for learning programimg. The perks of the mobile devices will be used to get unique and entertaining challenges which are seen as stimulating learning that is taking place beyond the barrier of space and time. Therefore, the programming's learning process will become more enjoyable and it will accomplish the goals of learning at anytime and anywhere.

This dissertation is integrated with Beaconing project. The aim of this project is to develop an alternative way of learning throw a gameful experience using pervasive, context-aware methodologies.

The work phases can be resumed in four steps: identify the game engine specifications, develop the game engine, develop a game prototype that integrates the Beaconing project and evaluate the solution developed.

The game engine resulting of this dissertation will allow other developers to create pervasive games for distinct areas of learning in a more enjoyable way.

Keywords: Pervasive games, learning programming, location-based games, mobile devices.

Resumo

Hoje em dia, enfrentamos um período de crescimento tecnológico que promove a aprendizagem da programação. No entanto, o processo de ensino desta área é complexo e abstrato, sendo que ao longo do tempo várias metodologias foram desenvolvidas para melhorar a motivação dos alunos.

Esta dissertação aproveita o facto de que os dispositivos móveis são parte do nosso uso diário e foca-se no desenvolvimento de um motor de jogo em Unity para implementar jogos pervasivos para a aprendizagem da programação. As vantagens dos dispositivos móveis são usadas para obter desafios que são vistos como sendo parte de uma aprendizagem estimulante e que têm lugar para além da barreira do espaço e do tempo. Portanto, o processo de aprendizagem da programação tornar-se-á mais divertida e alcançará os objetivos de aprender em qualquer momento e em qualquer lugar.

Esta dissertação é integrada ao projeto Beaconing. O objetivo deste projeto é desenvolver uma forma alternativa de aprender a lançar uma experiência de jogo usando metodologias pervasivas.

As fases de trabalho podem ser identificadas em quatro etapas: 1) identificar os requisitos e especificações do motor do jogo, 2) desenvolver o mecanismo do motor de jogo, 3) desenvolver um protótipo que integre o projeto Beaconing e, 4) avaliar a solução desenvolvida.

O motor do jogo resultante desta dissertação permitirá que outros programadores criem jogos pervasivos para aprendizagem em diversas áreas científicas de uma forma mais divertida.

Keywords: Pervasive games, learning programming, location-based games, mobile devices.

Acknowledgements

I would like to thank my supervisor, António Fernando Coelho, and co-supervisor, Pedro Jorge Couto Cardoso, for the opportunity granted to carry out this dissertation and for the continuous help, patience, support and guidance at every stage of this dissertation. I would also like to thank my parents and friends for the support at this phase.

Marina Camilo

"A dream doesn't become reality through magic;
it takes sweat, determination and hard work."

Colin Powell

Contents

Abbreviations

STEM	Science, Technology, Engineering and Mathematics
FEUP	Faculty of Engineering of the University of Porto
UTAD	Universidade de Trás-os-Montes e Alto Douro
LGB	Location-Based Game
AT	Authoring Tool
WWW	*World Wide Web*

Chapter 1

Introduction

Facing a time of globalization and technology expansion, Internet and mobile devices are popular and a tool to our daily lives. People are more connected and information is becoming more and more accessible thanks to this technology. On the other hand, games, videos, and other media can win in the fight for people's time and motivation.

Teaching is a complex process that requires a high degree of dedication and abstraction [Far17]. New methods to capture student's attention and motivation have risen in the last years. And today, the Internet, mobile devices, gamification and pervasive gaming seem promising media and strategies.

1.1 Context

In this dissertation, we will focus on the programming upskill, however, this can be adapted to any other subject. One of the focus of this dissertation is be to implement a game engine for Android applications that will access the users' location to trigger mini-games. After professors idealize a pervasive game driven by challenges with mini-games, students only need to open the Android application and head for the challenges' location. In order to do this, the application will show the challenges' and the users' location in real time.

This dissertation, besides being integrating with previous work by João Pascoal Faria [Far17], is integrated with the Beaconing project. The aim of this project is to develop an alternative way of learning resorting to a gameful experience using pervasive, context-aware methodologies. In this regard, the Android application, which contains the game engine, developed under this dissertation is a contribution to this project.

Beaconing[1] stands for *Breaking Educational Barriers with Contextualised, Pervasive and*

[1] http://beaconing.eu/

Gameful Learning and is focused on 'anytime anywhere' learning by exploiting pervasive, context-aware and gamified techniques and technologies, framed under the Problem-Based Learning approach. This project's main goals are:

1. *"**Integrate technologies, pedagogical and social perspectives** using pervasive, context-aware and gamified approaches ensuring that the BEACONING platform is innovative while also extending our scientific understanding and practice-based experiments of engaging a community of learners including those with disabilities with a more inclusive, connected and contextualised learning process.*
2. ***Develop, implement and validate the BEACONING platform that:***
   - *leverages cutting-edge approaches including the Future Internet technology, mobile, gamification, pervasive gaming, procedural game content generation, game authoring, human-computer interfaces, learning analytics and problem-based learning model;*
   - *is usable, adaptable, extendable and sustainable.*
3. ***Explore and measure the level of engagement, effectiveness and impact** that is enabled by the BEACONING platform towards incentivizing learners and fostering acquisition and transfer of knowledge and skills, validate this through large scale pilots involving a community of stakeholders and practitioners in Europe, and provide an exploitation and business plan for the platform adoption."*

1.2 Motivation and Goals

The main goal of this dissertation is to implement a game engine capable to integrate the BEACONING project. Serious games, that use pervasive methodologies, will follow the structure of the previous work accomplished by João Pascoal Faria [Far17], challenges with mini-games associated and a geographical location that boosts the users to find them. In order to accomplish this idea, the Android application will be capable to:

- Connect to BEACONING server to fetch the challenges location and to send feedback accordingly to the user's accomplishments.
- Authenticate the user.
- Show user's profile information as well as the challenges.
- Read the challenges data and show its location accordingly in a map as the user's location.
- Update user's location when the user moves.
- Open the mini-games when the user's location overlap any of the presented challenges.

- Verify the user's answer to the challenge.
- Show more challenges when user's level increase.

1.3 Dissertation Structure

This dissertation contains 3 more chapters after this one. Chapter 2, describes the state of the art and presents related works. Chapter 3 shows the problem and explores the proposed solution. In this chapter we also explore the implementation of the prototype. In chapter 4, are presented the conclusions and possible future work.

Chapter 2

Related Work

2.1 Introduction

We will begin by introducing the three main subjects that this dissertation focuses on.

- **Serious games** are games designed for a purpose other than pure entertainment, such as education, training, informing, etc.
- **Pervasive games** are games that break the barrier between the digital and real world, that use real-world information into the game itself. The real world becomes a game board, reality becomes part of the game.
- **Location-Based Games** are those that use players physical location as input in the game logic. These games are one example of pervasive games.

2.2 Pervasive Games and Education

Nowadays, pervasive games are becoming a tool in today's teaching. Users would learn "at the speed of need through formal, informal and social learning modalities" [SSI15]. For example, *ClueKing* [CN17], a children's pervasive game uses challenges in order to maintain the interest of their player. *ClueKing* [CN17] involves teachers and parents in education. As professors set the learning goals and challenges, parents only need to assure their children conditions when playing under their supervision. Like treasure hunting, the players will find the next challenge in a physical position. Using a mobile device they can find QR codes or encounter a bluetooth beacon device in order to continue playing.

Another example of gamified informal learning experience with multi-aged users can be found in museums [CC17]. Users that use the application have challenges in order to collect stickers to put in their digital album.

2.3 Location-Based Games

Location-based games are one example of exergames, defined by D.Charles and B.Magerko as games that are able to change accordingly to user's input [JNCR], because they use that input in the game logic. This means these games rely on user's real-time location in order to be played.

The calculation of a a user's physical location relies upon GPS-module or location-based services such as the strength Wi-Fi signal [LC07]. As a result, these games are almost solely found on mobile platforms due to its specifications [JC11]. As location-based games are a particular case of pervasive games, one can consider that "mobile phones with [...] wearable machines, sensors, and so forth are pervasive in nature" [SSI15].

However, these games are known to become unplayable or to provide a limited gaming experience in several circumstances. For example, GPS signal cannot be used indoors, in which determining the user's physical location depends on the match of Wi-Fi and device's sensors (gyroscope, accelerometer) [Coe15]. Also, connecting to the Internet anytime, anywhere, can result in costs for the user. This is an obstacle for the functioning of the game if the required information is located remotely [JC11].

2.3.1 Solutions for Location-Based Games' Issues

João Jacob and António Coelho [JC11] identify 5 issues and respective solutions for location-based games:

- **Game-design issues regarding safety:** When users will interact with the real world, safety needs to be taken into account. Gameplay should prevent the user from putting himself in danger. In other words, a location-based game involves some degree of unpredictability so it is important to predict where and how the player will try to play the game. It is essential to get solutions to guarantee the users' safeness. Solutions like reducing unpredictability of the user by using the gameplay to limit her behaviour. For, example, if the game is a race that is intended to be played on foot, to avoid cheating using motorized vehicles, the velocity shouldn't go over 30 Km/h.

- **Hardware limitations:** Contrarily to other games where user's action or the game's requirements are limited by the developer, location-based games normally use GPS and Wi-Fi which it can limit user's experience and the possibility of playing the game. To overlap the location requirement, the location could be set from logs or be set directly by the user.

- **Location-related information availability and suitability:** Games normally use maps, weather information, or any kind of location-related information. However, there are places in the world where this information is unavailable, doesn't exist, cannot be used, or has values that are impossible. Here are three solutions when the data we need produces an unplayable game. The first solution randomly generates data according to user's GPS position creating a new virtual novelty. Alternatively, knowing the capacity of storage of mobile devices is on the tens of gigabytes, it is possible to download every piece of information needed

to assure the novelty of the location. However, this information can become outdated. The last solution is to use a remotely stored location-related content that is often updated via web services. However, this last one needs to use data connections and could not be available for every playable location. Some games even use the user's device to gather the location-based data when the game is been played.

- **Player's fitness and pace:** In most location-based games the user's movement is the input for the game itself. This is one obstacle that this type of games faces. Users are different from each other, and by taking into account the travel distance, the average speed, and the current speed, etc., the game may become easier for the fit players and a challenge for the unfit. Therefore, it is important for the game to understand the player's movement and adapt its difficulty in order to maintain the effort value equal independently of the user.

- **Player's data protection:** The people's data privacy is an increasingly more important issue. When playing a location-based game the information on user's location, like coordinates, is often cached either for future use or statistical purposes. Therefore, user's data should be kept remotely under authentication process. However, if the game could not guarantee its safety, user's should be alerted.

Facing these issues, their article proposes a framework for the creation of mobile location-based games that would incorporate some of these solutions. For location proposes they use Google's georeferencing web service and Google Map's static API. For weather proposes they use webservicex.net Weather web service.

Furthermore, João Jacob, Rui Nóbrega, António Coelho e Rui Rodrigues refer [JNCR] that another problem is daily life.

Ghost Chase [JNCR] is a game where the goal is to run from ghosts and encounter a safe house before ghosts find the player. It takes into account time of the day, weather, conditions, type of road, real-time traffic information among other things, in order to foster adaptivity regards the user and safety. This way, whenever the player is near a crosswalk the game will automatically know that the spawn between ghosts should be reduced as a precaution of user's harm.

2.3.2 Overlap Common Location Technologies Errors

According to André Pinto, António Coelho e Hugo da Silva [PCDS12] there are some restrictions when using GPS (indoor usage, city canyons, or other physical obstacles) and WLAN (deteriorates in dynamic non-line-of-sight situations) to find the users' physical position.

This paper presents a solution that combines methods to determine orientation, detect steps an estimate their length. It was implemented a pedestrian dead reckoning method that uses the sensors available in the mobile devices such as accelerometer, magnetometer and gyroscope. This approach produced encouraging results, however, the accuracy of this solution still depends on the sensors data reality.

2.4 Maps

The information of our streets, buildings and even trees can be programmed to be almost the way they are in reality. This functionality can be founded on our smartphones in apps as *Google Maps, Meo Drive, Pokemon Go*. However, where some companies code their own vision of the world, there is some API's that can already provide that information. There are three popular API's: *Google Maps*, *Microsoft Bing Maps* and *OpenStreetMap*.

2.4.1 Google

Besides its interactive map, Google Maps offers a range of APIs and Web services [Goo] [Is2] such as:

- **Geocoding** - Converts an address into coordinates and vice-versa.
- **Directions** - Calculates a route between two positions taking into account the transport method of choice.
- **Google places** - Combines more information about companies and their location and help the user to find the location while typing.

However, all these services have a cost. Despite the standard license that can be obtained for free, when used in a daily basis it was quite limited and unadvisable when used professionally.

2.4.2 Bing

> "The Bing Maps APIs include map controls and services that you can use to incorporate Bing Maps in applications and websites. In addition to interactive and static maps, the APIs provide access to other geospatial features such as geocoding, route and traffic data and spatial data sources that you can use to store and query data that has a spatial component, such as store locations." [Bina]

The Bing Maps API are a total of five APIs that can be accessed with the same key [Binb]:

- ***V8 Web Control:*** *The Bing Maps V8 control is one of the most universal mapping controls available. Not only is it supported on standard PC and Mac browsers, but it is also supported on many mobile platforms. This maps API is ideal for web-based applications with support for JavaScript and TypeScript.*
- ***Windows 10 Universal Windows Platform:*** *The Windows 10 Universal Windows Platform lets you build map apps that target a range of Windows 10 devices, including phones, tablets and desktop PCs. Use familiar technologies, like C sharp and XAML, to quickly build robust apps. In Windows 10, you can also leverage world-class Aerial 3D and Streetside imagery as a backdrop for making your app and your data look great.*

- ***Windows Presentation Foundation:*** *The Bing Maps API featuring Windows Presentation Foundation (WPF) is an excellent control for creating desktop-based applications. It is specifically designed with touch controls that work with the Microsoft Surface tablet.*
- ***REST Services:*** *The Bing Maps REST Services are excellent services for performing tasks such as geocoding, reverse-geocoding, routing and static imagery. Being that this is a REST-based maps API, it can be easily accessed from almost any development environment.*
- ***Spatial Data Services:*** *The Bing Spatial Data Services are REST-based maps API services that offer three key functionalities: batch geocoding, point of interest (POI) data and the ability to store and expose your spatial data. These services are ideal for those who need a place to store their spatial data or who need point of interest data in their application.*

However, only three of them are cross-platform, the first, the third and fourth correspondingly. Although the Basic Bing Maps key is free, it is limited by the number of transactions.

2.4.3 Open Street Maps

OpenStreetMap [Ope] values local knowledge and it is developed by a voluntary community of mappers. Its employees use aerial photographs, GPS devices, and terrain maps to verify that the information in OpenStreetMap is accurate and up-to-date. Besides the advantage that anyone can richen its content, it is the fact that OpenStreetMap data is open source which results on the freedom of using it for any purpose if the authorship of OpenStreetMap and its collaborators are provided with the corresponding credit. Likewise, if you change or create something using its data.

2.5 Summary and Conclusions

In summary, several solutions and research exist about the main topics in the areas where this dissertation is inserted. We can conclude that some of the pervasive methodologies used in education are a base of the work that BEACONING is developing.

Also, the location-based game issues introduce a new whole context of what not to do and how to do well when developing the solution for this dissertation. It's essential to pay attention to the target players and their differences, as well, adapting the game to the chosen location and type of game. It's also essential to use a good representation on the map at this context. This means, between the solutions that exist today the best one is using the OpenStreetMap [Ope] database because it is free and it also possibilities the user to enter more data easily.

Although, there are some solutions that use location-based technology, there is still a lack of solutions that can allow adaptation of the game to each individual student or even to a whole class using mobile devices applications, in order to facilitate the context of learning in anytime, anywhere.

Chapter 3

Solution

3.1 Design

In this chapter is explored the planning phase of the final prototype. As mentioned before, the goal is to achieve an application that incorporates a game engine which will create a location-based game. This game is the client-side of an authorization tool from a previous dissertation.

3.1.1 Requirements

At the beginning of the implementation was created a document with the requirements that explores the work to be done and future features. Therefore, the approved final requirements are expressed in the following table.

Table 3.1: Requirements of the proposed solution

Req#	Requirement	Status	Priority
RF_01	It should be possible to see the player's location on the map.	Done	High
RF_02	The application should represent the player's location on the map through configurable Avatars.	Future Work	Low
RF_03	The user should be able to rotate and resize the map.	Done	Medium
RF_04	The map should focus the player's representation according to their location and compass.	Done	Low
RF_05	The user should be able to complete the challenges / mini-games in fullscreen.	Done	High
RF_06	The application should be able to incorporate games from different platforms without being web based.	Future Work	Low
RF_07	The application must be able to interpret a JSON data file.	Done	High

Req#	Requirement	Status	Priority
RF_08	The User must be able to view and collect its score taking into account the performance in the mini-games and along the activity.	Future work	Medium
RF_09	The system should allow sending data in order to allow its analysis.	Future work	Low
RF_10	The application must support user authentication when necessary.	Future work	Medium
RF_11	The application should be able to direct the user to the next mini-game without the use of the map.	Done	Low
RF_12	The enter panel of the mini-game should pop up when a user arrives at its location.	Done	Medium
RF_13	The user must be able to check in and enter the mini-game when it is near its location.	Done	Medium
RF_14	The application should not allow user's access to the mini-game if it is not within the minimum geographical distance required by the system.	Done	High
RF_15	The user should be able to keep the items that it conquers in its challenges at the application as well as visualizing them.	Future work	Low
RF_16	The application should be able to draw the best path between two points.	Future work	Low
RF_17	The application should allow certain sectors of the map to be exchanged with treated images.	Future work	Low
RF_18	The application should display the location of the user even when it is inside buildings.	Future work	Low
RF_19	The user should be able to change the application settings.	Done	Low
RF_20	The user must be able to access the mini-games he has already played.	Done	Medium
RF_21	The application should be able to work offline.	Future work	Low
RF_22	The application should ask the user for permission to access the GPS location of the device.	Done	High
RF_23	The application should allow to retry the mini-game.	Done	Low

However, due to the fact that this project is associated with the European Project Beaconing [H20], as mentioned in chapter 1, it was created in association with another workgroup from Trás-os-Montes e Alto Douro University (UTAD). As a result, some requirements were added to the project (despicted in Appendix A). The RA_03, RA_05, RA_06, RA_07, RA_08, RA_13 requirements were implemented.

3.1.2 Architecture

The proposed solution integrates several systems of Beaconing. To understand the architecture of the implemented solution it's essential to know what Beaconing [H20] already has.

Before this dissertation, it was elaborated an authoring tool were creates a Game Lesson Plan (GLP) which can contain Location based-games (LBG). An LBG consists of activities where each one incorporates a mini-game or a checkpoint. The mini-game goal is to teach or check the content learned. Therefore, each LBG activity has a latitude and a longitude associated. In theory, after the GLP is defined a JSON file (Appendix B and C) is created and its available in Beaconing [H20] server.

Nevertheless, as mentioned in the last section, at the same time a team at UTAD was studying the acessability of Beaconing's product to its users. In other words, they developed a program that Beaconing's users would use to configure several issues about Accessibility. This program exports a JSON file that keeps all their definitions and would be kept in Beaconing's server attached to their profile (Appendix D).

Finally, after knowing what existed and cognizant the requirements featured in the last section, we will explore the mobile application that will contain the proposed solution. This application was also an element of study in technical terms by this dissertation which turned out to be part of the proposed solution.

On starting up, the application contains the main panel consisting of the most relevant menus like language, definitions, activities and log in. After the user logs in, it downloads the JSON file from UTAD mentioned above in this chapter. After this action, the definitions menu would be updated with the new information. It is possible to change the definitions, after the package was loaded, however, it will not change the information in the server. Notice that is not mandatory that every user logs in. As a result of the possibility of GLPs opened for anyone to participate. This scenario was also contemplated due to the fact of the Authoring Tool allows configuring games for entities such as museums, parks, etc. In this case, the user will be provided with a random login in order to record its actions. In addition, the activities menu will also change accordingly the login status but, how does it work? The activities menu will request the Game Lesson Plans to the Beaconing server for the user in question. I will be presented the free activities and also the ones where the user is integrated. When an activity is selected to play it will enter in the game mode.

The game mode will get the information of the activity and the configurations of the user. It will also start the Geostream plugin [JLN+18] [GJR+15] (mentioned in the previous chapter)

that will render the map, the player, and it will interpret the information present in each activity of the Game Lesson Plan as represented in figure 3.1.

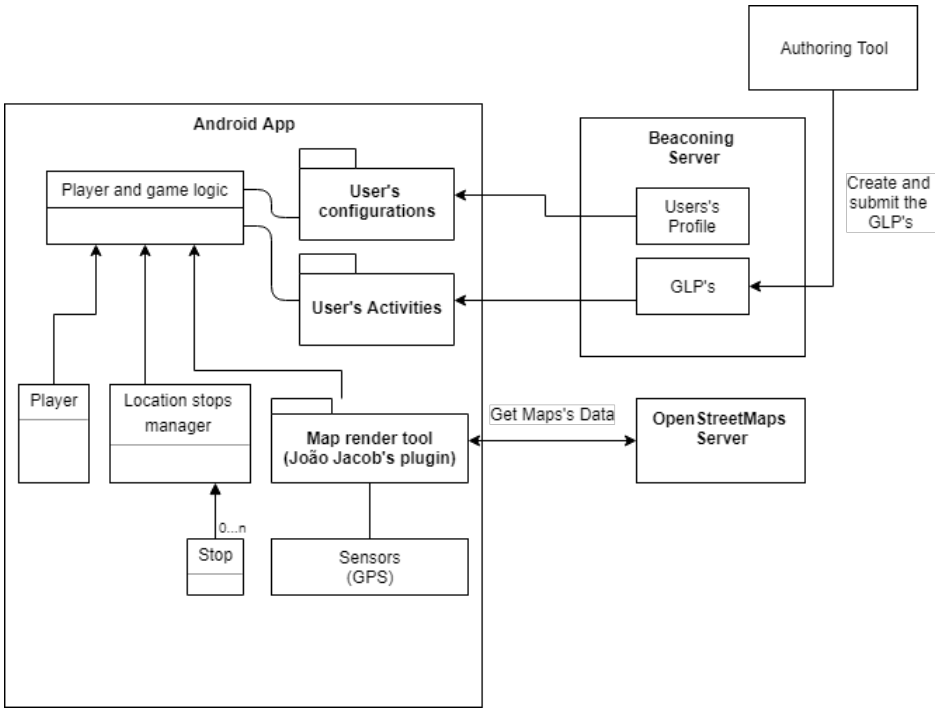


Figure 3.1: Proposed Solution Diagram

3.1.3 Wireframes

This prototype wireframes were produced by a team of students, professors and researchers integrated into the European Project Beaconing [H20]. Therefore, Appendix E presents final representation of the application. This dissertation was more specific on the Map part represented by figures 3.2, 3.3, 3.4, 3.5 and 3.6.

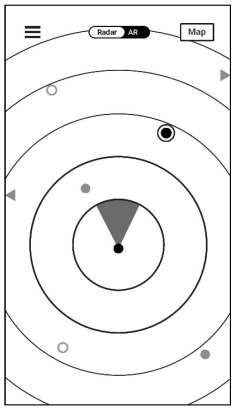


Figure 3.2: Map Panel

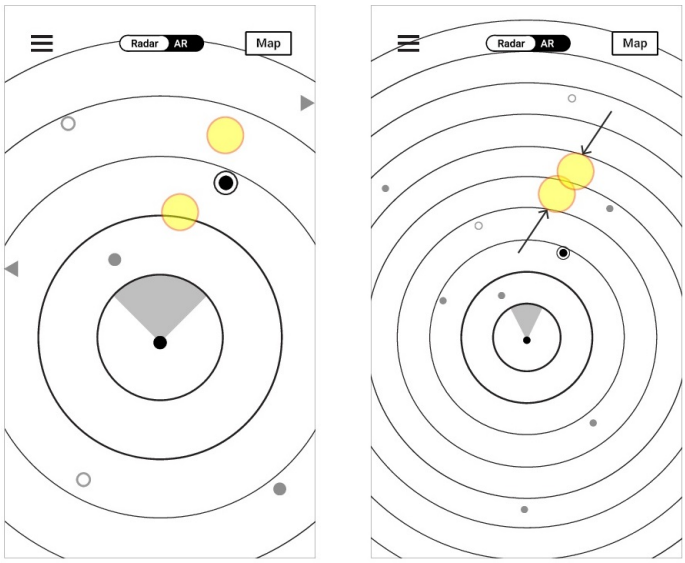


Figure 3.3: Resize Map Panel

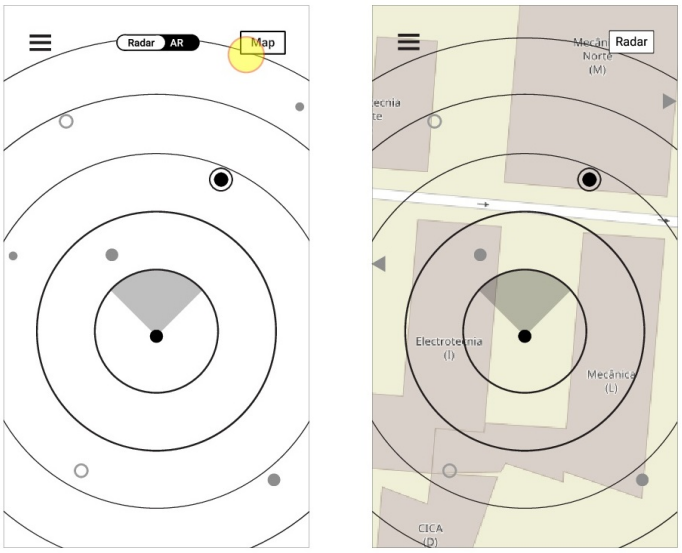


Figure 3.4: Visualize the rendered Map

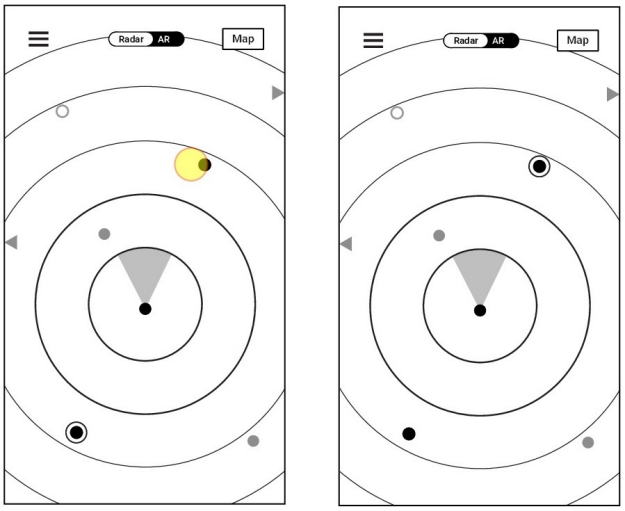


Figure 3.5: Mark a point

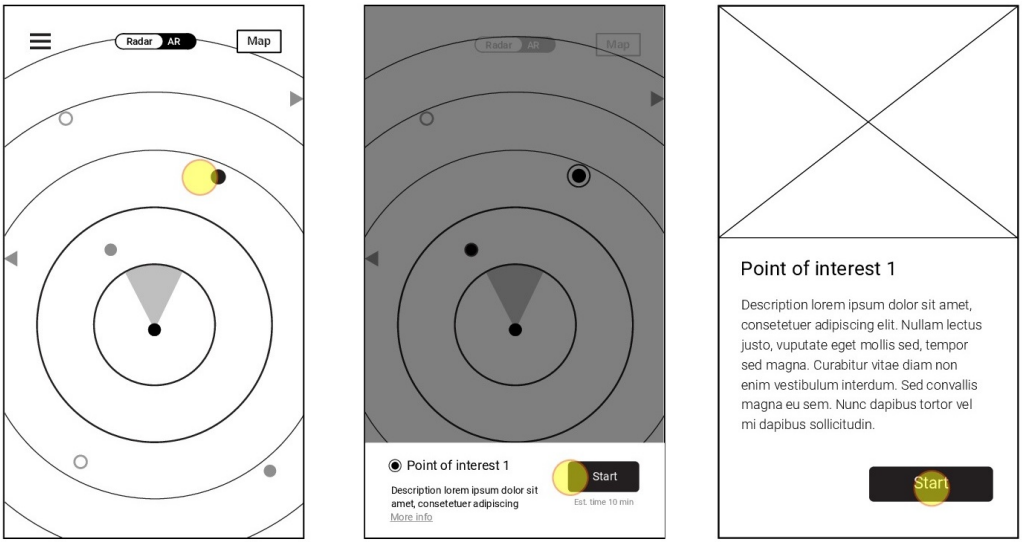


Figure 3.6: Enter the mini-game panel

3.1.4 Technologies

The technologies were another aspect taking into account when implementing the solution. Comparing the different technologies in the market like Cordova or WebGL it was decided to use Unity particularity because it is itself a Game Engine and a powerful tool when we talk about graphics programming.

As the wireframes specify, the big challenge was the rendering of the map. In chapter 2, it was explored some of the existing APIs/databases that provide maps information. At the end of the chapter, it was concluded that the best one regarding this project was using the OpenStreetMap

[Ope]. However, it was still necessary to render the information provided. Therefore, some of the packages that can be used to render OpenStreetMap [Ope] data are the following [Uni]:

- Mantle
- map-ity
- Mapbox Unity SDK
- Tangram
- Online Maps and Real World Terrain
- UtyMap
- Geostream

Except for the UtyMap, the packages are all paid. Nevertheless, it existed another program possible to read and render the map. This program was made by Professor's João Jacob [JLN+18] [GJR+15] and one of the impressive functionalities is it works offline after it downloads the maps. Therefore, it was the chosen one even though UtyMap [Uty] was tested for the same effect.

3.2 Implementation

3.2.1 Android App

The implementation first started with the self-learning about the technologies that were necessary to create an android game in unity. Besides, the first task was the render of the map. It was quite a challenge regards the existing technologies. The best solution was Geostream [JLN+18] [GJR+15]. However, the solution needed to be adapted in order to be a module in order to change if necessary. The next phase was the radar. The radar was considered the main system to find mini-games due to the fact of a previous test at the Botanic Garden by the design team. In this test, the users had to walk throw the Porto's Botanic Garden in order to find the mini-games and, consequently know more about the content of this garden. The method used was the map, something that capt the player's attention. In order to prevent the constant use of the mobile device, it was developed a radar perspective to make it easier for the player to find the mini-games without permanently checking his position on the phone. At this point, the proposed solution is represented in figure 3.7.

Currently, the player and the mini-game points were fixed in the screen. However, the map solution was conquered on changing the cameras of Geostream [JLN+18] [GJR+15] to be synchronized with the radar camera and changing the map transformation accordingly to the GPS in contrast to the player's transformation done by the solution. Also at this phase was possible to change between radar camera and map camera throw the buttons represented by "M" (Map) and "R" (Radar). It was also possible to see the automatically transition to the radar mode upon 10

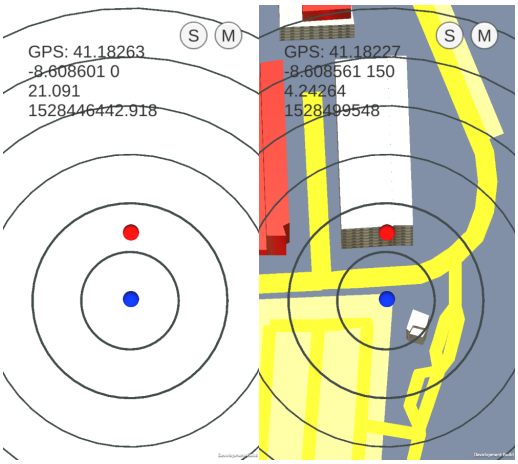


Figure 3.7: Screenshot of the first phase of the application

seconds after entering the map mode. The "S" button was a debug button in order to show/hide the GPS coordinates represented in the figure 3.7.

The next phase started on making the radar lines configurable. It was also represented by the implementation of the resize screen. The second phase is represented in the figure 3.8.

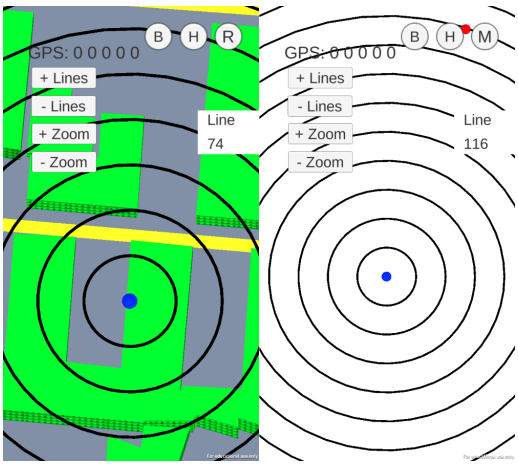


Figure 3.8: Screenshot of the second phase of the application

The radar lines can change in thickness accordingly to the user's preferences. It was also defined that the first two lines would be thicker than the rest. The radius of the circles was also stipulated to be *radius x i*, where *i* represents the number of the circle in ascending order. About the resize part, it was stipulated that the maximum block of the map shown to the user was until *radius x 5 x 2* meters (representing the device screen width) and the minimum was *radius x 3 x 2* meters.

The last phase was represented by implementing the code to enter the mini-game points and mark them. It was also implemented the logic which makes them always to be represented on

screen. In the end, the proposed solution improved the previous parts in other to become closer to the wireframes. The third phase is represented in the figure 3.9.

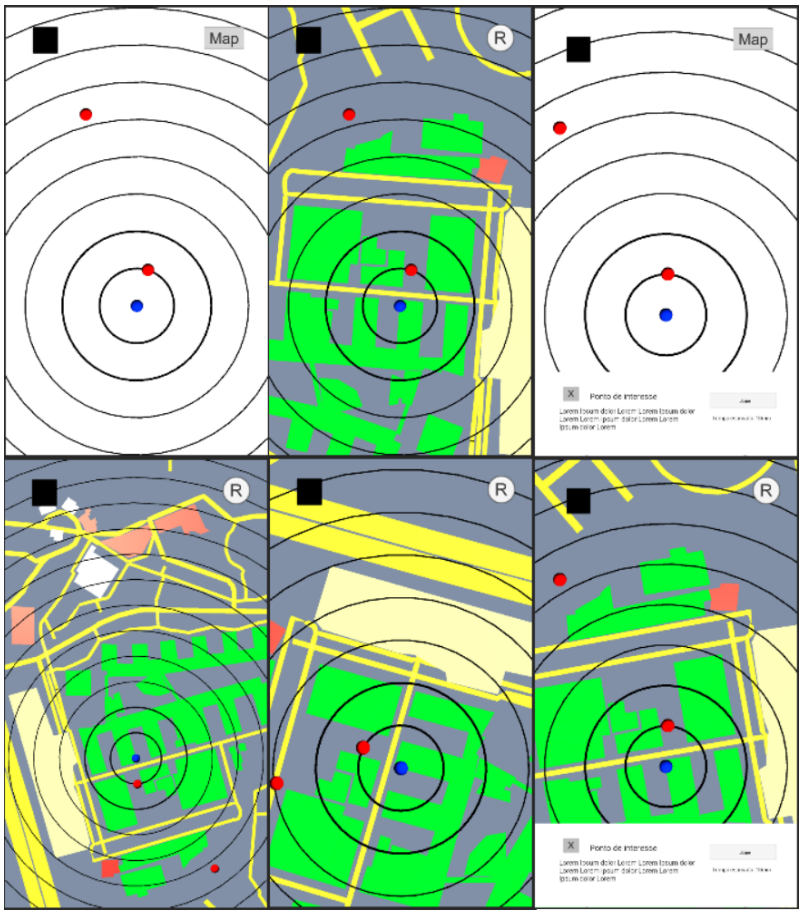


Figure 3.9: Screenshot of the third phase of the application

In this phase, the work of the intern Hugo Reis was merged, the interface with the information about the mini-game was done by him.

3.2.2 Evaluation and Validation

To validate the work done it was created a test scenario. At this scenario existed two points related as mini-games at latitude 41.183834 and longitude -8.607407 and at latitude 41.182878 and longitude -8.608559. The next requirements were tested in this scenario:

Table 3.2: Requirements that were tested in the test scenario

Req#	**Action Expected**	**Action Done**	**Status**
RF_01	It should be possible to see the player's location on the map.	The player's location is updated on the map when the player moves corresponding to the player's latitude and longitude.	Approved

Req#	Action Expected	Action Done	Status
RF_03	The user should be able to rotate and resize the map.	The user resizes the map with the movement of two touches approaching and moving away. The user rotates the map with the two touches rotation.	Approved
RF_04	The map should focus the player's representation according to their location and compass.	The user's representation is always centred in the screen and when the user is not touching the screen the map rotates according to the device orientation.	Approved
RF_12	The enter panel of the mini-game should pop up when a user arrives at its location.	When the mini-game location was close to the player's location, the panel popped-up.	Approved
RF_13	The user must be able to check in and enter the mini-game when it is near its location.	When the mini-game location was sufficiently close to the player's location, the panel popped-up when the mini-game point was touched.	Approved
RF_14	The application should not allow user's access to the mini-game if it is not within the minimum geographical distance required by the system.	When the mini-game location was far away from the player's location, the panel didn't popped-up when the mini-game point was touched.	Approved
RF_19	The user should be able to change the application settings.	When the user enters the application it is possible to change the colours and other settings in the settings panel. These settings are maintained when the user enters in the application again.	Approved
RF_20	The user must be able to access the mini-games he has already played.	After a mini-game point changed colour, the panel of the mini-game popped-up when the mini-game point is tapped.	Approved
RF_22	The application should ask the user for permission to access the GPS location of the device.	When the user enters in the application for the first time, It is presented to the user the permissions that he should accept in order to play the game as it is supposed.	Approved

The figure 3.10 is one screenshot from the test scenario. The requirements RF_05, RF_07 and RF_23 from table 3.1 could not be tested because the Beaconing server was not ready. However, this features are already implemented and can be tested after the Beaconing server is ready. It was also verified the change of the mini-game point status.

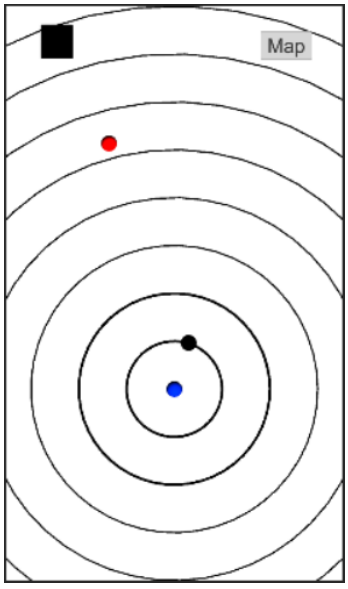


Figure 3.10: Screenshot of test mode

Solution

Chapter 4

Conclusions

4.1 Goals Satisfaction

The application implemented in the scope of this dissertation has the main menu where it is possible to configure the type and size of the letter, the colours, the contrast, and some other options from accessibility. It is also possible to change the language of the application. It is possible to check the available activities which are available to the user and play them as well. This dissertation focus on the last part, location-based games. When a user starts to play an activity, it is shown a radar which indicates the location of the mini-games. The mini-games are represented by circles with different colours that symbolize done, not done and marked activities. It is possible to mark an activity by touching it and confirming on a panel. It is also possible to see more info on the mini-game when the mini-game enters the closest circle of the radar. However, it is possible to access the same panel if the mini-game point is tapped and is inside the second closest circle of the radar. All the mini-games that should be shown on the radar never leave the screen limits. The player moves towards the map accordingly to the GPS location and its possible to resize the map between certain predefined values.

To conquer this solution there were some obstacles along the way. The map was a subject of study and its connexion with the rest of the rest of the game had many changes during the implementation process. The Unity technology was also an obstacle. Besides the powerful tool that Unity is, the Android build in unity is not accomplished with the most recent versions of the SDK tools and Java JDK. Contrarily, it was a long process to achieve the match of the versions that work on the working unity version. The unity updates that happen along this dissertation process didn't help either because when the work was merged from multiple parts, as Paulo Pinheiro by UTAD, and from the intern, Hugo Reis, combined also different unity versions, with different SDK and JDK. This results in missing configurations that needed to be manually checked. However, besides all the obstacles encountered the main requirements established in chapter 3 were accomplished.

4.2 Future Work

For future work, this solution could implement the missing requirements represented in chapter 3 (4.1), for example, change player's icon for a configurable avatar and add 3D perspective to the map. The application could user's data for analyse such as player's trajectory. For future work, the user could have an inventory that keeps the items won in the mini-games.

Table 4.1: Future work requirements

Req#	**Requirement**	**Status**	**Priority**
RF_02	The application should represent the player's location on the map through configurable Avatars.	Future Work	Low
RF_06	The application should be able to incorporate games from different platforms without being web based.	Future Work	Low
RF_08	The User must be able to view and collect its score taking into account the performance in the mini-games and along the activity.	Future work	Medium
RF_09	The system should allow sending data in order to allow its analysis.	Future work	Low
RF_10	The application must support user authentication when necessary.	Future work	Medium
RF_15	The user should be able to keep the items that it conquers in its challenges at the application as well as visualizing them.	Future work	Low
RF_16	The application should be able to draw the best path between two points.	Future work	Low
RF_17	The application should allow certain sectors of the map to be exchanged with treated images.	Future work	Low
RF_18	The application should display the location of the user even when it is inside buildings.	Future work	Low
RF_21	The application should be able to work offline.	Future work	Low

For future work, the application could work offline. Also, augmented reality could be used in order to send the player to the next mini-game.

References

[Arn15] Sylvester Arnab. Learning Environment System Specification. (687676), 2015.

[BAH+17] A. Bourazeri, S. Arnab, O. Heidmann, A. Coelho e L. Morini. Taxonomy of a gamified lesson path for STEM education: The beaconing approach. *Proceedings of the 11th European Conference on Games Based Learning, ECGBL 2017*, 2017.

[Bina] Bing Maps. Accessed: 22/06/2018. URL: https://msdn.microsoft.com/en-us/library/dd877180.aspx.

[Binb] Bing Maps API's. Accessed: 22/06/2018. URL: https://www.microsoft.com/en-us/maps/choose-your-bing-maps-api.

[CC17] António Coelho e Luís Miguel Costa. The integration of augmented reality and the concept of sticker album collection for informal learning in museums. *Communications in Computer and Information Science*, 725:107–115, 2017. doi:10.1007/978-3-319-60633-0_9.

[CN17] Vanessa Ces e Valentina Nisi. Serious Games, Interaction and Simulation. 176:23–30, 2017. URL: http://link.springer.com/10.1007/978-3-319-51055-2, doi:10.1007/978-3-319-51055-2.

[Coe15] Antonio Fernando Coelho. Location-based Games, 2015. URL: https://blog.eai.eu/location-based-games/.

[Far17] João Miguel Polónia Pascoal Faria. Jogos pervasivo para o ensino. 2017. URL: https://repositorio-aberto.up.pt/handle/10216/106178.

[GJR+15] João S V Gonçalves, João Jacob, Rosaldo J F Rossetti, António Coelho e Rui Rodrigues. An Integrated Framework for Mobile-Based ADAS Simulation. In Michael Behrisch e Melanie Weber, editors, *Modeling Mobility with Open Data*, pages 171–186, Cham, 2015. Springer International Publishing.

[Goo] Google Maps Platform. Accessed: 22/06/2018. URL: https://developers.google.com/maps/current-pricing.

[H20] H2020 beaconing. Accessed: 07/02/2018. URL: https://cordis.europa.eu/project/rcn/199217_en.html.

[Is2] Is the Usage of Google Maps Free? Accessed: 22/06/2018. URL: https://ubilabs.net/en/news/google-maps-apis-licensing-2016-04-21.

[JC11] Joo Tiago Pinheiro Neto Jacob e Antnio Fernando Coelho. Issues in the development of location-based games. *International Journal of Computer Games Technology*, 2011, 2011. doi:10.1155/2011/495437.

[JLN+18] João Jacob, Ana Lopes, Rui Nóbrega, Rui Rodrigues e António Coelho. Player Adaptivity and Safety in Location-Based Games. In Adrian David Cheok, Masahiko Inami e Teresa Romão, editors, *Advances in Computer Entertainment Technology*, pages 219–238, Cham, 2018. Springer International Publishing.

[JNCR] João Jacob, Rui Nóbrega, António Coelho e Rui Rodrigues. Adapivity and Safety in Location-Based Games. pages 5–6. doi:10.1109/VS-GAMES.2017.8056592.

[LC07] Dik Lun Lee e Qiuxia Chen. A Model-Based WiFi Localization Method. *Water*, 59:1–7, 2007. URL: http://dl.acm.org/citation.cfm?id=1366856, doi:10.3114/sim.2007.59.04.

[Mos97] Robert Moser. A fantasy adventure game as a learning environment: Why learning to program is so difficult and what can be done about it . *ITiCSE '97 Proceedings of the 2nd conference on Integrating technology into computer science education*, pages 114–116, 1997. doi:10.1145/268809.268853.

[Ope] OpenStreetMaps. Accessed: 22/06/2018. URL: https://www.openstreetmap.org/about.

[PCDS12] André Pinto, António Coelho e Hugo Da Silva. A ubiquitous solution for location-aware games. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 7522 LNCS:578–583, 2012. doi:10.1007/978-3-642-33542-6_76.

[Per16] Daniel Borges Pereira. Jogo Baseado na Localização para a Otimização da Experiência Turística Jogo Baseado na Localização para a Otimização da. page 77, 2016. URL: http://hdl.handle.net/10216/85770.

[SSI15] Liyana Shuib, Shahaboddin Shamshirband e Mohammad Hafiz Ismail. A review of mobile pervasive learning: Applications and issues. *Computers in Human Behavior*, 46:239–244, 2015. URL: http://dx.doi.org/10.1016/j.chb.2015.01.002, doi:10.1016/j.chb.2015.01.002.

[Uni] UnityOSMTools. Accessed: 22/06/2018. URL: https://wiki.openstreetmap.org/wiki/Unity.

[Uty] UtyMap. Accessed: 22/06/2018. URL: https://github.com/reinterpretcat/utymap.

Appendix A

Acessibility Requirements by UTAD (Paulo Pinheiro)

Table A.1: Accessibility Requirements by Paulo Pinheiro (UTAD)

Req#	**Requirement**	**Status**	**Type**
RA_01	Allow controller reconfiguration.	Allow controller reconfiguration: remap keys and camera control.	MOTOR
RA_02	Allow controller reconfiguration	Adjust the sensitivity controls	MOTOR
RA_03	Color-blind friendly design.	Provide high contrast between text/UI and background.	VISUAL
RA_04	Color-blind friendly design.	Color-blind Options	VISUAL
RA_05	High visibility graphics.	Ensure no essential information is conveyed by a colour alone.	VISUAL
RA_06	High visibility graphics.	Use an easily readable default font size.	VISUAL/ COGNITIVE
RA_07	High visibility graphics.	Use simple clear text formatting.	VISUAL/ COGNITIVE
RA_08	High visibility graphics.	Allow the font size and colour to be adjusted.	VISUAL/ AUDIO
RA_09	Offer sound alternatives.	Provide subtitles for all important speech.	AUDIO
RA_10	Sound Compass.	Use surround sound.	VISUAL
RA_11	Sound Compass	Provide separate volume controls or mutes for effects, speech and background/music.	VISUAL
RA_12	Standard Text Presentation.	Ensure screen reader support, including menus & installers.	VISUAL
RA_13	Standard Text Presentation.	Use simple clear language.	COGNITIVE

Appendix B

Game Lesson Plan: JSON Example


```
{
"id": "689",
"name": "Test document glp",
"description": "lala",
"domain": "",
"topic": "",
"age_group": "",
"year": "2018",
"update_gpi_url": "",
"external_edit_url": "",
"learning_objectives": "",
"competences": "",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
"contributes": {
"learningObjectives": [
{
"name": "",
```

```
"percentage": 0
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
},
"level": 0
},
"missions": [
{
"id": "dr8dcchvg0",
"name": "First Mission",
"description": "la",
"skills": "",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
"contributes": {
"learningObjectives": [
```

```
{
"name": "",
"percentage": 0
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
},
"level": 1
},
"quests": [
{
"id": "u4y29v7qcw",
"name": "First Quest Name",
"locationBased": "false",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
"contributes": {
```

```
"learningObjectives": [
{
"name": "",
"percentage": 0
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
},
"level": 2
},
"graph": {
"scenes": [
{
"id": "0",
"title": "Entrance",
"x": 35,
"y": 157,
"width": 150,
"height": 120,
"color": "#BADA55",
"externals": [],
"challenges": [
{
"id": "0",
"title": "Challenge2",
"name": "Challenge2",
"description": "",
"x": "65",
"y": "217",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
```

```
"playURL": [],
"locations": [
"Entrance"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": [
{
"name": "  Solve IT ",
"session_id": "1889876408",
"configuration": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gameconfig&key=1889876408",
"configurationAT": "{\"session_id\":\"1889876408\",\"repository_game_name\":\"SI_GAME\",\"displayed_game_name\":\"Solve It Game\",\"lang\":\"en\",\"game_description\":\"Insert the correct numbers\nto complete the equations\",\"lesson_plan_id\":689,\"user_token\":\"\",\"timeout\":8,\"topic\":\"math\",\"subtopic\":\"\",\"level\":\"veryeasy\",\"operation_type\":\"+\",\"input_direction\":\"ltr\",\"num_operands\":\"2\",\"stages\":\"1\",\"pausable\":false,\"accessible\":false,\"correctAnswerPoints\":\"Missing Number\",\"successPoints\":\"Missing Number\",\"passed_message\":\"\",\"failed_message\":\"\",\"analytics\":{\"correct_answers\":false,\"single_elapsed_time\":false,\"total_elapsed_time\":false,\"wrong_answers\":false,\"skipped_answers\":false}}",
"schema": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gamejsondescriptor&gname=SI_GAME",
"resources": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gamejsonresources&gname=SI_GAME",
"runtime": "https://beaconing.seriousgames.it/games/solveit/?session_id=",
"update": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=updategameconfig",
"load": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=gameconfig&key=",
"externalAT": "undefined",
"minigame": "true",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
```

```
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
"contributes": {
"learningObjectives": [
{
"name": "one",
"percentage": 0.2
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
},
"level": 3
},
"updateAnalytics": "https://beaconing.seriousgames.it/v1/api.php?service=
    gameservices&action=savemetainfo"
}
]
}
],
"connections": [],
"locationBasedGames": []
},
{
"id": "1",
"title": "RoomOff",
"x": 67,
"y": 18,
"width": 270,
"height": 120,
```

```
"color": "#BADA55",
"externals": [],
"challenges": [
{
"id": "0",
"title": "Challenge3",
"name": "Challenge3",
"description": "",
"x": "97",
"y": "78",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"RoomOff"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
},
{
"id": "1",
"title": "Challenge4",
"name": "Challenge4",
"description": "",
"x": "217",
"y": "78",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"RoomOff",
"RoomOff_2"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
}
],
"connections": [],
"locationBasedGames": []
```

```
},
{
"id": "2",
"title": "RoomOn",
"x": 32,
"y": 559,
"width": 86.703125,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "3",
"title": "SecurityGate",
"x": 614,
"y": 309,
"width": 270,
"height": 120,
"color": "#BADA55",
"externals": [],
"challenges": [
{
"id": "0",
"title": "Challenge1A",
"name": "Challenge1A",
"description": "",
"x": "644",
"y": "369",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"SecurityGate"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": [
{
"name": "  Drag IT ",
"session_id": "b6d27b6a-220f-4e58-80bc-db5f06f26651",
"configuration": "",
"configurationAT": "\"\"",
```

```
"schema": "",
"resources": "",
"runtime": "https://minigames.beaconing.eu/games/dragit/#play/",
"update": "https://minigames.beaconing.eu/newGameId?type=dragit",
"load": "",
"externalAT": "https://minigames.beaconing.eu/games/dragit/#edit/",
"minigame": "true",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
"contributes": {
"learningObjectives": [
{
"name": "one",
"percentage": 0.2
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
```

```
},
"level": 3
},
"updateAnalytics": ""
}
]
},
{
"id": "1",
"title": "Challenge1B",
"name": "Challenge1B",
"description": "",
"x": "764",
"y": "369",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"SecurityGate"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
}
],
"connections": [],
"locationBasedGames": []
},
{
"id": "4",
"title": "MeetingRoom",
"x": 615,
"y": 158,
"width": 119.375,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "5",
"title": "RoomOff_2",
"x": 105,
```

```
"y": 501,
"width": 390,
"height": 180,
"color": "#BADA55",
"externals": [],
"challenges": [
{
"id": "0",
"title": "Challenge5",
"name": "Challenge5",
"description": "",
"x": "135",
"y": "561",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"RoomOff_2"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
},
{
"id": "2",
"title": "POI test",
"name": "POI test",
"description": "",
"x": "255",
"y": "561",
"isLocationBased": true,
"isBeacon": false,
"type": "create",
"playURL": [],
"locations": [],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
},
{
"id": "7263",
"title": "Begin",
```

```
"name": "7263",
"description": "Begin",
"x": "375",
"y": "561",
"isLocationBased": true,
"isBeacon": false,
"type": "checkin",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=0",
"https://atcc.beaconing.eu/app.php?game=998&teleport=",
"https://atcc.beaconing.eu/app.php?game=998&step=0"
],
"locations": [],
"beaconID": "",
"coords": {
"lat": 41.1781,
"lng": -8.59084
},
"activities": []
},
{
"id": "7264",
"title": "First stop",
"name": "7264",
"description": "First stop",
"x": "135",
"y": "621",
"isLocationBased": true,
"isBeacon": false,
"type": "upload",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=1",
"https://atcc.beaconing.eu/app.php?game=998&teleport=any",
"https://atcc.beaconing.eu/app.php?game=998&step=1"
],
"locations": [],
"beaconID": "",
"coords": {
"lat": 41.1746,
"lng": -8.59294
},
"activities": []
},
{
"id": "7265",
"title": "Challengue",
"name": "7265",
"description": "Challengue",
"x": "255",
```

```
"y": "621",
"isLocationBased": true,
"isBeacon": false,
"type": "minigame",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=2",
"https://atcc.beaconing.eu/app.php?game=998&teleport=",
"https://atcc.beaconing.eu/app.php?game=998&step=2"
],
"locations": [],
"beaconID": "",
"coords": {
"lat": 41.176,
"lng": -8.59813
},
"activities": [
{
"name": "  Solve IT ",
"session_id": "3543742402",
"configuration": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices
    &action=gameconfig&key=3543742402",
"configurationAT": "{\"repository_game_name\":\"SI_GAME\",\"displayed_game_name
    \":\"Solve It Game\",\"lang\":\"en\",\"game_description\":\"Insert the correct
    numbers\nto complete the equations\",\"lesson_plan_id\":689,\"user_token
    \":\"\",\"timeout\":6,\"topic\":\"math\",\"subtopic\":\"\",\"level\":\"veryeasy
    \",\"operation_type\":\"+\",\"input_direction\":\"ltr\",\"num_operands
    \":\"2\",\"stages\":\"1\",\"pausable\":false,\"accessible\":false,\"
    correctAnswerPoints\":\"Missing Number\",\"successPoints\":\"Missing Number
    \",\"passed_message\":\"\",\"failed_message\":\"\",\"analytics\":{\"
    correct_answers\":false,\"single_elapsed_time\":false,\"total_elapsed_time\":
    false,\"wrong_answers\":false,\"skipped_answers\":false}}",
"schema": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action
    =gamejsondescriptor&gname=SI_GAME",
"resources": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&
    action=gamejsonresources&gname=SI_GAME",
"runtime": "https://beaconing.seriousgames.it/games/solveit/?session_id=",
"update": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action
    =updategameconfig",
"load": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=
    gameconfig&key=",
"externalAT": "undefined",
"minigame": "true",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
```

```
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
"contributes": {
"learningObjectives": [
{
"name": "",
"percentage": 0
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
},
"level": 3
},
"updateAnalytics": "https://beaconing.seriousgames.it/v1/api.php?service=
    gameservices&action=savemetainfo"
}
]
},
{
"id": "7267",
"title": "Reward",
"name": "7267",
"description": "Reward",
"x": "375",
```

```
"y": "621",
"isLocationBased": true,
"isBeacon": true,
"type": "minigame",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=3",
"https://atcc.beaconing.eu/app.php?game=998&teleport=",
"https://atcc.beaconing.eu/app.php?game=998&step=3"
],
"locations": [],
"beaconID": "ORT salle physique MINT",
"coords": {
"lat": 48.846249625465,
"lng": 2.260412976794
},
"activities": [
{
"name": "  Solve IT ",
"session_id": "",
"configuration": "",
"configurationAT": "\"\"",
"schema": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action
    =gamejsondescriptor&gname=SI_GAME",
"resources": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&
    action=gamejsonresources&gname=SI_GAME",
"runtime": "https://beaconing.seriousgames.it/games/solveit/?session_id=",
"update": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action
    =updategameconfig",
"load": "https://beaconing.seriousgames.it/v1/api.php?service=gameservices&action=
    gameconfig&key=",
"externalAT": "undefined",
"minigame": "true",
"analytics": {
"json": {
"analytics": {
"limits": {
"maxTime": 120,
"maxAttempts": 3,
"partialThreshold": {
"learningObjectives": 0.5,
"competences": 0.5,
"scores": 0.5
},
"fullThreshold": {
"learningObjectives": 0.7,
"competences": 0.7,
"scores": 0.7
}
},
```

```
"contributes": {
"learningObjectives": [
{
"name": "",
"percentage": 0
}
],
"competences": [
{
"name": "",
"percentage": 0
}
]
},
"active": false,
"success": 0,
"completion": 0,
"startTime": 0,
"endTime": 0,
"elapsedTime": 0,
"attempts": 0,
"results": [
""
]
}
},
"level": 3
},
"updateAnalytics": "https://beaconing.seriousgames.it/v1/api.php?service=
    gameservices&action=savemetainfo"
}
]
}
],
"connections": [
{
"source": "7263",
"target": "7264"
},
{
"source": "7264",
"target": "7265"
},
{
"source": "7265",
"target": "7267"
}
],
"locationBasedGames": [
```

```
{
"singlePOI": "false",
"gameID": "998",
"name": "listOfPOI test",
"type": "Treasure Hunt",
"editURL": "https://atcc.beaconing.eu/treasure-hunt.php",
"updateURL": "https://atcc.beaconing.eu/php/updatePlot.php",
"startURL": "https://atcc.beaconing.eu/app.php?game=998",
"endURL": "https://atcc.beaconing.eu/app.php?game=998&teleport=finish",
"description": "",
"updateData": {
"id": "998",
"startURL": "https://atcc.beaconing.eu/app.php?game=998",
"endURL": "https://atcc.beaconing.eu/app.php?game=998&teleport=finish",
"data": [
{
"name": "7263",
"descr": "Begin",
"beacon": false,
"locked": false,
"value": "",
"type": "checkIn",
"whereInGLP": "M0/Q0/S5",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=0",
"https://atcc.beaconing.eu/app.php?game=998&teleport=",
"https://atcc.beaconing.eu/app.php?game=998&step=0"
],
"outputs": [
"7264"
]
},
{
"name": "7264",
"descr": "First stop",
"beacon": false,
"locked": false,
"value": "",
"type": "uploadContent",
"whereInGLP": "M0/Q0/S5",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=1",
"https://atcc.beaconing.eu/app.php?game=998&teleport=any",
"https://atcc.beaconing.eu/app.php?game=998&step=1"
],
"outputs": [
"7265"
]
},
```

```
{
"name": "7265",
"descr": "Challengue",
"beacon": false,
"locked": false,
"value": "https://beaconing.seriousgames.it/games/solveit/?session_id=3543742402",
"type": "minigameURL",
"whereInGLP": "M0/Q0/S5",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=2",
"https://atcc.beaconing.eu/app.php?game=998&teleport=",
"https://atcc.beaconing.eu/app.php?game=998&step=2"
],
"outputs": [
"7267"
]
},
{
"name": "7267",
"descr": "Reward",
"beacon": true,
"locked": false,
"value": "",
"type": "minigameURL",
"whereInGLP": "M0/Q0/S5",
"playURL": [
"https://atcc.beaconing.eu/app.php?game=998&map=3",
"https://atcc.beaconing.eu/app.php?game=998&teleport=",
"https://atcc.beaconing.eu/app.php?game=998&step=3"
],
"outputs": []
}
]
},
"locations": [
"RoomOff_2"
],
"nodes": [
7263,
7264,
7265,
7267
]
},
{
"singlePOI": "true",
"gameID": "",
"name": "POI test",
"type": "",
```

```
"editURL": "",
"updateURL": "",
"startURL": "",
"endURL": "",
"description": "",
"updateData": "{\"id\":\"\",\"startURL\":\"\",\"endURL\":\"\",\"data\":[{\"name
    \":\"POI test\",\"descr\":\"POI test\",\"beacon\":false,\"locked\":false,\"
    value\":\"\",\"type\":\"ERROR\",\"whereInGLP\":\"/S5\",\"playURL\":[],\"outputs
    \":[]}]}",
"locations": [
"RoomOff_2"
],
"nodes": [
2
]
}
]
},
{
"id": "6",
"title": "MeetingRoom_2",
"x": 230,
"y": 83,
"width": 136.046875,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "7",
"title": "RoomOff_3",
"x": 535,
"y": 673,
"width": 102.421875,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "8",
"title": "MeetingRoom_3",
"x": 724,
"y": 129,
```

```
"width": 150,
"height": 120,
"color": "#BADA55",
"externals": [
{
"name": "Branch",
"type": "int",
"description": "",
"value": "3",
"scenes": [
"MeetingRoom_3"
]
},
{
"name": "DifficultyLevel",
"type": "int",
"description": "",
"value": "0",
"scenes": [
"MeetingRoom_3"
]
},
{
"name": "slot16",
"type": "string",
"description": "",
"value": "No link delivered",
"scenes": [
"MeetingRoom_3"
]
},
{
"name": "stop12_easy",
"type": "string",
"description": "",
"value": "http://beaconing.seriousgames.it/games/solveit/?session_id=1505",
"scenes": [
"MeetingRoom_3"
]
},
{
"name": "stop12_hard",
"type": "string",
"description": "",
"value": "http://beaconing.seriousgames.it/games/solveit/?session_id=1507",
"scenes": [
"MeetingRoom_3"
]
},
```

```
{
"name": "stop12_medium",
"type": "string",
"description": "",
"value": "http://beaconing.seriousgames.it/games/solveit/?session_id=1506",
"scenes": [
"MeetingRoom_3"
]
},
{
"name": "stop14",
"type": "string",
"description": "",
"value": "Gate: I don’t have the link!",
"scenes": [
"MeetingRoom_3"
]
}
],
"challenges": [
{
"id": "0",
"title": "Challenge6",
"name": "Challenge6",
"description": "",
"x": "754",
"y": "189",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"MeetingRoom_3"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
}
],
"connections": [],
"locationBasedGames": []
},
{
"id": "9",
"title": "Entrance_2",
"x": 574,
```

```
"y": 63,
"width": 102.71875,
"height": 57,
"color": "#BADA55",
"externals": [
{
"name": "Dialog_3_1",
"type": "string",
"description": "",
"value": "I Didn't wanted to do this! He forced me to remove some parts and told
    that no one will know. I owed him a certain amount of money.",
"scenes": [
"Entrance_2"
]
},
{
"name": "Dialog_3_2",
"type": "string",
"description": "",
"value": "He didn't told his full name, i called him Mark.",
"scenes": [
"Entrance_2"
]
},
{
"name": "Dialog_3_3",
"type": "string",
"description": "",
"value": "...we should met at the cafe on the Saint George street in few days. At
    eight p.m.",
"scenes": [
"Entrance_2"
]
},
{
"name": "Dialog_3_4",
"type": "string",
"description": "",
"value": "Please help me not to lost my work",
"scenes": [
"Entrance_2"
]
},
{
"name": "NPC_2",
"type": "string",
"description": "",
"value": "Janitor",
"scenes": [
```

```
"Entrance_2"
]
}
],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "10",
"title": "MeetingRoom_4",
"x": 785,
"y": 14,
"width": 136.046875,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "11",
"title": "TechRoom",
"x": 60,
"y": 195,
"width": 97.6875,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "12",
"title": "Entrance_FindingParts",
"x": -2,
"y": 294,
"width": 179.078125,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "13",
```

```
"title": "LoungeRoom_FindingParts",
"x": 47,
"y": 419,
"width": 209.109375,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "14",
"title": "Entrance_FindingParts_2",
"x": 681,
"y": 629,
"width": 195.265625,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "15",
"title": "SecurityGate_FindingParts",
"x": 293,
"y": 662,
"width": 205.75,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "16",
"title": "Entrance_FindingParts_3",
"x": 506,
"y": 391,
"width": 195.265625,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
```

```
},
{
"id": "17",
"title": "SecurityGate_FindingParts_2",
"x": 222,
"y": 674,
"width": 221.9375,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "18",
"title": "Entrance_FindingParts_4",
"x": 71,
"y": 237,
"width": 195.265625,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "19",
"title": "RoomOff_FindingParts",
"x": 316,
"y": 416,
"width": 178.78125,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "20",
"title": "SecurityGate_FindingParts_3",
"x": 306,
"y": 436,
"width": 221.9375,
"height": 57,
"color": "#A3E",
"externals": [],
```

```
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "21",
"title": "RoomOff_FindingParts_2",
"x": 34,
"y": 333,
"width": 194.96875,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "22",
"title": "LoungeRoom",
"x": 609,
"y": 273,
"width": 116.0625,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "23",
"title": "LoungeRoom_2",
"x": 586,
"y": 50,
"width": 132.75,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "24",
"title": "MeetingRoom_5",
"x": 565,
"y": 294,
"width": 136.046875,
```

```
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "25",
"title": "RoomOff_4",
"x": 527,
"y": 505,
"width": 102.421875,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "26",
"title": "MeetingRoom_6",
"x": 235,
"y": 34,
"width": 136.046875,
"height": 57.000015258789,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "27",
"title": "Entrance_Janitor",
"x": 242,
"y": 188,
"width": 140.390625,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "28",
"title": "RoomOn_2",
```

```
"x": 236,
"y": 385,
"width": 102.703125,
"height": 57,
"color": "#A3E",
"externals": [],
"challenges": [],
"connections": [],
"locationBasedGames": []
},
{
"id": "29",
"title": "LoungeRoom_3",
"x": 672,
"y": 669,
"width": 150,
"height": 120,
"color": "#BADA55",
"externals": [],
"challenges": [
{
"id": "0",
"title": "Challenge7",
"name": "Challenge7",
"description": "",
"x": "702",
"y": "729",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"LoungeRoom_3"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
}
],
"connections": [],
"locationBasedGames": []
},
{
"id": "30",
"title": "MeetingRoom_Finish",
"x": 1009,
```

```
"y": 663,
"width": 150,
"height": 120,
"color": "#BADA55",
"externals": [],
"challenges": [
{
"id": "0",
"title": "Challenge8",
"name": "Challenge8",
"description": "",
"x": "1039",
"y": "723",
"isLocationBased": false,
"isBeacon": false,
"type": "minigame",
"playURL": [],
"locations": [
"MeetingRoom_Finish"
],
"beaconID": "",
"coords": {
"lat": 0,
"lng": 0
},
"activities": []
}
],
"connections": [],
"locationBasedGames": []
}
],
"connections": [
{
"source": "0",
"target": "1"
},
{
"source": "0",
"target": "11"
},
{
"source": "1",
"target": "2"
},
{
"source": "2",
"target": "4"
},
```

```
{
"source": "3",
"target": "0"
},
{
"source": "3",
"target": "29"
},
{
"source": "4",
"target": "28"
},
{
"source": "4",
"target": "5"
},
{
"source": "5",
"target": "8"
},
{
"source": "6",
"target": "7"
},
{
"source": "6",
"target": "22"
},
{
"source": "6",
"target": "23"
},
{
"source": "7",
"target": "8"
},
{
"source": "7",
"target": "26"
},
{
"source": "7",
"target": "29"
},
{
"source": "8",
"target": "9"
},
{
```

```
"source": "9",
"target": "10"
},
{
"source": "11",
"target": "1"
},
{
"source": "12",
"target": "13"
},
{
"source": "12",
"target": "15"
},
{
"source": "13",
"target": "14"
},
{
"source": "14",
"target": "15"
},
{
"source": "15",
"target": "16"
},
{
"source": "15",
"target": "18"
},
{
"source": "15",
"target": "19"
},
{
"source": "16",
"target": "17"
},
{
"source": "17",
"target": "19"
},
{
"source": "17",
"target": "18"
},
{
"source": "18",
```

```
"target": "20"
},
{
"source": "19",
"target": "20"
},
{
"source": "20",
"target": "21"
},
{
"source": "21",
"target": "2"
},
{
"source": "22",
"target": "26"
},
{
"source": "22",
"target": "25"
},
{
"source": "23",
"target": "24"
},
{
"source": "23",
"target": "7"
},
{
"source": "24",
"target": "22"
},
{
"source": "25",
"target": "26"
},
{
"source": "26",
"target": "9"
},
{
"source": "28",
"target": "29"
},
{
"source": "29",
"target": "30"
```

```
}
]
}
}
]
}
]
}
```

Appendix C

Scene: JSON Example

The next Json represent an activity that is possible to access throw the activity panel.

```
{
    "id": "5",
    "title": "RoomOff_2",
    "x": 105,
    "y": 501,
    "width": 390,
    "height": 180,
    "color": "#BADA55",
    "externals": [],
    "challenges": [{
            "id": "7263",
            "title": "Begin",
            "name": "7263",
            "description": "Begin",
            "x": "375",
            "y": "561",
            "isLocationBased": true,
            "isBeacon": false,
            "type": "checkin",
            "playURL": [
                "https://atcc.beaconing.eu/app.php?game=998&map=0",
                "https://atcc.beaconing.eu/app.php?game=998&teleport=",
                "https://atcc.beaconing.eu/app.php?game=998&step=0"
            ],
            "locations": [],
            "beaconID": "",
            "coords": {
                "lat": 41.1781,
                "lng": -8.59084
            },
            "activities": []
        },
```

Scene: JSON Example

```
        {
            "id": "7264",
            "title": "First stop",
            "name": "7264",
            "description": "First stop",
            "x": "135",
            "y": "621",
            "isLocationBased": true,
            "isBeacon": false,
            "type": "upload",
            "playURL": [
                "https://atcc.beaconing.eu/app.php?game=998&map=1",
                "https://atcc.beaconing.eu/app.php?game=998&teleport=any",
                "https://atcc.beaconing.eu/app.php?game=998&step=1"
            ],
            "locations": [],
            "beaconID": "",
            "coords": {
                "lat": 41.1746,
                "lng": -8.59294
            },
            "activities": []
        },
        {
            "id": "7265",
            "title": "Challengue",
            "name": "7265",
            "description": "Challengue",
            "x": "255",
            "y": "621",
            "isLocationBased": true,
            "isBeacon": false,
            "type": "minigame",
            "playURL": [
                "https://atcc.beaconing.eu/app.php?game=998&map=2",
                "https://atcc.beaconing.eu/app.php?game=998&teleport=",
                "https://atcc.beaconing.eu/app.php?game=998&step=2"
            ],
            "locations": [],
            "beaconID": "",
            "coords": {
                "lat": 41.176,
                "lng": -8.59813
            },
            "activities": [{
                "name": "  Solve IT ",
                "session_id": "3543742402",
                "configuration": "https://beaconing.seriousgames.it/v1/api.php?
                    service=gameservices&action=gameconfig&key=3543742402",
```

Scene: JSON Example


```
                "configurationAT": "{\"repository_game_name\":\"SI_GAME\",\"
                    displayed_game_name\":\"Solve It Game\",\"lang\":\"en\",\"
                    game_description\":\"Insert the correct numbers\nto complete
                    the equations\",\"lesson_plan_id\":689,\"user_token\":\"\",\"
                    timeout\":6,\"topic\":\"math\",\"subtopic\":\"\",\"level\":\"
                    veryeasy\",\"operation_type\":\"+\",\"input_direction\":\"ltr
                    \",\"num_operands\":\"2\",\"stages\":\"1\",\"pausable\":false
                    ,\"accessible\":false,\"correctAnswerPoints\":\"Missing Number
                    \",\"successPoints\":\"Missing Number\",\"passed_message
                    \":\"\",\"failed_message\":\"\",\"analytics\":{\"
                    correct_answers\":false,\"single_elapsed_time\":false,\"
                    total_elapsed_time\":false,\"wrong_answers\":false,\"
                    skipped_answers\":false}}",
                "schema": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=gamejsondescriptor&gname=SI_GAME",
                "resources": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=gamejsonresources&gname=SI_GAME",
                "runtime": "https://beaconing.seriousgames.it/games/solveit/?
                    session_id=",
                "update": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=updategameconfig",
                "load": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=gameconfig&key=",
                "externalAT": "undefined",
                "minigame": "true",
                "analytics": {...},
                "updateAnalytics": "https://beaconing.seriousgames.it/v1/api.php?
                    service=gameservices&action=savemetainfo"
            }]
        },
        {
            "id": "7267",
            "title": "Reward",
            "name": "7267",
            "description": "Reward",
            "x": "375",
            "y": "621",
            "isLocationBased": true,
            "isBeacon": true,
            "type": "minigame",
            "playURL": [
                "https://atcc.beaconing.eu/app.php?game=998&map=3",
                "https://atcc.beaconing.eu/app.php?game=998&teleport=",
                "https://atcc.beaconing.eu/app.php?game=998&step=3"
            ],
            "locations": [],
            "beaconID": "ORT salle physique MINT",
            "coords": {
                "lat": 48.846249625465,
```

Scene: JSON Example


```
                "lng": 2.260412976794
            },
            "activities": [{
                "name": "  Solve IT ",
                "session_id": "",
                "configuration": "",
                "configurationAT": "\"\"",
                "schema": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=gamejsondescriptor&gname=SI_GAME",
                "resources": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=gamejsonresources&gname=SI_GAME",
                "runtime": "https://beaconing.seriousgames.it/games/solveit/?
                    session_id=",
                "update": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=updategameconfig",
                "load": "https://beaconing.seriousgames.it/v1/api.php?service=
                    gameservices&action=gameconfig&key=",
                "externalAT": "undefined",
                "minigame": "true",
                "analytics": {...},
                "updateAnalytics": "https://beaconing.seriousgames.it/v1/api.php?
                    service=gameservices&action=savemetainfo"
            }]
        }
    ],
    "connections": [{
            "source": "7263",
            "target": "7264"
        },
        {
            "source": "7264",
            "target": "7265"
        },
        {
            "source": "7265",
            "target": "7267"
        }
    ],
    "locationBasedGames": [{
            "singlePOI": "false",
            "gameID": "998",
            "name": "listOfPOI test",
            "type": "Treasure Hunt",
            "editURL": "https://atcc.beaconing.eu/treasure-hunt.php",
            "updateURL": "https://atcc.beaconing.eu/php/updatePlot.php",
            "startURL": "https://atcc.beaconing.eu/app.php?game=998",
            "endURL": "https://atcc.beaconing.eu/app.php?game=998&teleport=finish",
            "description": "",
            "updateData": {...},
```

```
            "locations": [
                "RoomOff_2"
            ],
            "nodes": [
                7263,
                7264,
                7265,
                7267
            ]
        }
    ]
}
```

Scene: JSON Example

Appendix D

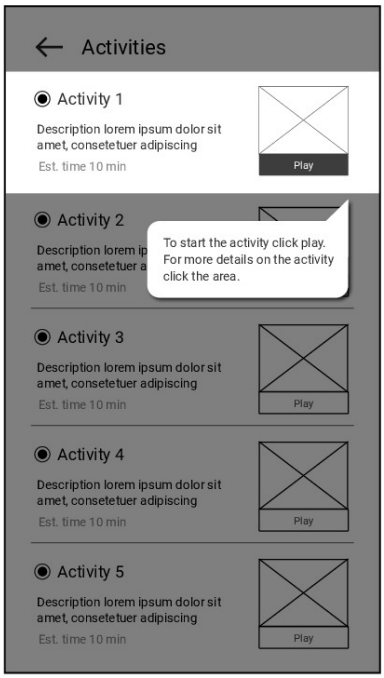
Accessibility JSON by UTAD

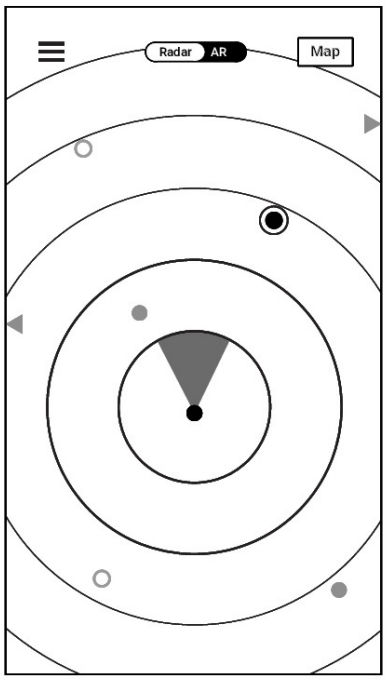
```
{
    "userAccessibility": {
        "screenReader": true|false,
        "fontSize":small|normal|medium|big,
        "fontType":calibri|trebuchet|arial|arialBlack|comicSans|verdana|tahoma|
            georgia,
        "contrastMode":normal|BW|WB|BY|YB,
        "flashingText": true|false,
        "blinkingText": true|false,
        "keyboardOnly": true|false,
        "voiceInterface": true|false,
        "speechRecognition": true|false
    }
}
```

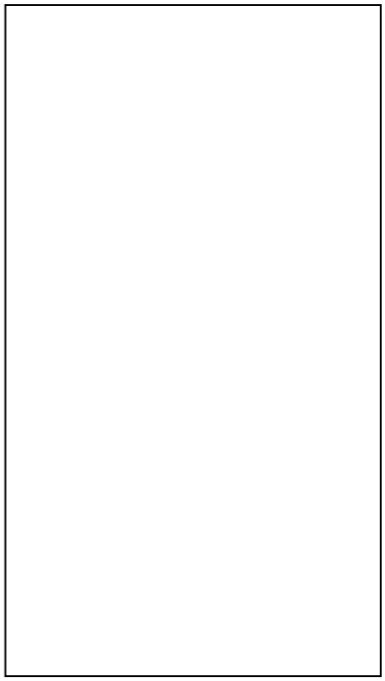
Appendix E

Wireframes by Beaconing Design team

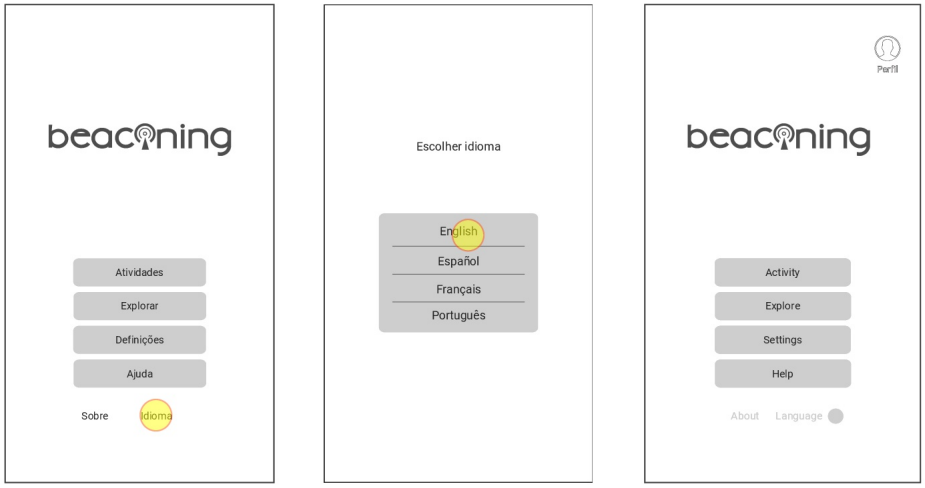
TUTORIAL



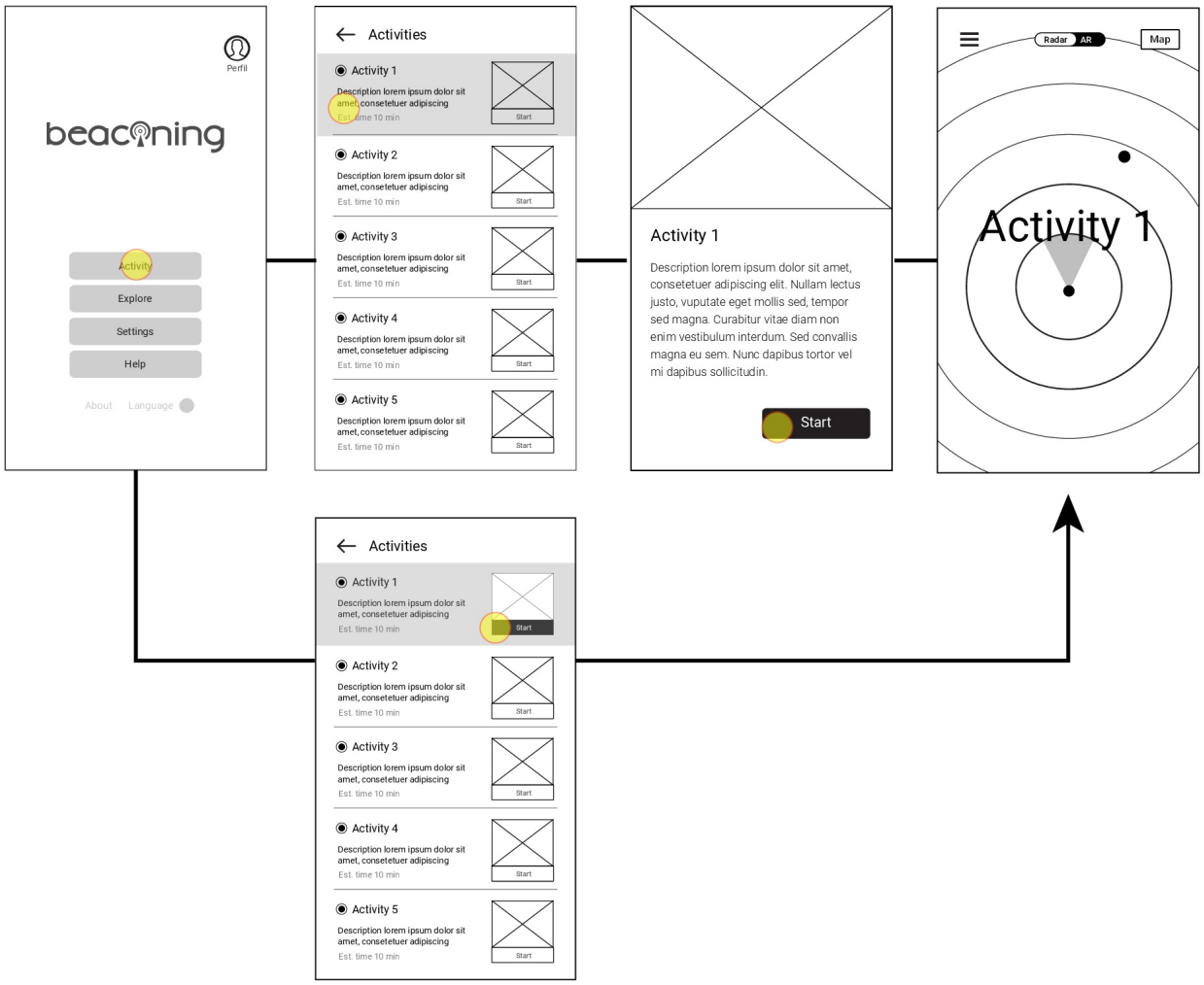


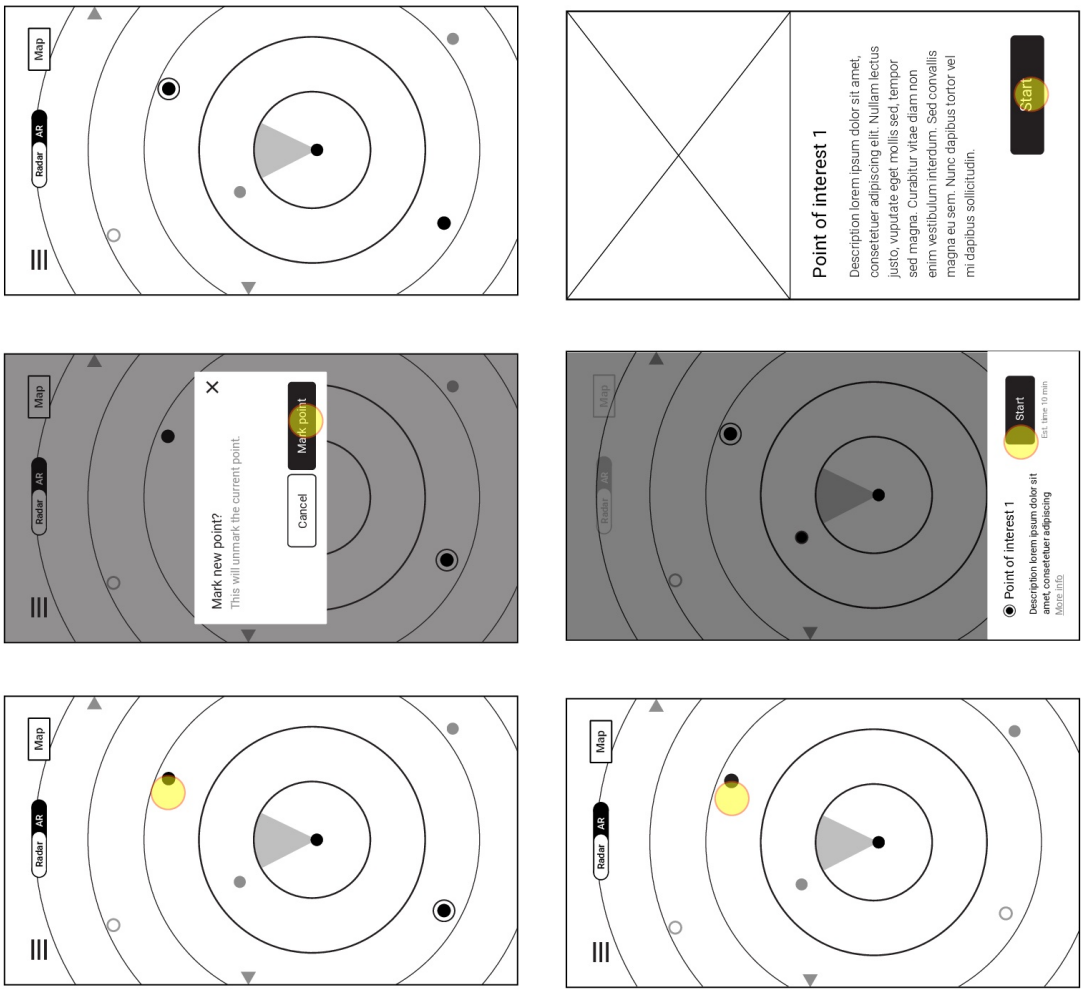


User Path
Alteração de linguagem



User Path
Selecionar e começar atividade





User Path
Marcar um ponto

Para marcar tap and hold

User Path
Jogar mini jogo

Wireframes by Beaconing Design team